PRIMARY/SECONDARY WIRELESS PROTECTOR

BACKGROUND OF THE INVENTION

This invention relates generally to primary/secondary surge protection devices for protecting telephone communications related equipment from power and transient surges. More particularly, the present invention relates to an improved primary/secondary surge protector circuit for protecting telecommunication equipment from power and transient surges occurring on the tip and/or ring conductors of transmission lines connected thereto. Specifically, the primary/secondary surge protector circuit of the instant invention includes fusible links of a unique construction connected in series with a primary voltage suppressor formed as a single unit on a printed circuit board.

As is generally well-known to those skilled in the telecommunications industry, modern telecommunications equipment is susceptible to transient surges such as those caused by lightning strikes and other voltage surges on the transmission lines. Accordingly, primary surge protector circuits are known in the prior art which have been provided for connection to the incoming transmission lines so as to be normally non-conductive but are rendered conductive when a voltage surge exceeds a predetermined breakdown voltage (e.g., 250 V) for protecting the equipment. However, it is also known that voltage surges on the transmission lines which are well below the breakdown

voltage of the primary surge protector circuit may nevertheless create possible damage to the equipment. Thus, telecommunication equipment manufacturers have also typically provided some type of secondary surge protection in conjunction with the primary surge protector circuits.

As is shown in Figure 1, a prior art primary/secondary surge protector circuit includes a primary protector portion and a secondary protector portion. The primary protector portion is comprised of a primary voltage suppressor and a pair of bridle wires connected in series with the opposite ends of the voltage suppressor which are mounted on a printed circuit board. The bridle wires are either short pieces of gauged wire (e.g., #28 AWG size or less) or a fuse element. The bridle wires are required in order to meet or pass the primary test according to the specification set forth by UL Standards 497 and 497A. However, the use of the bridle wires in the form of short wires or fuse elements mounted on the printed circuit board has the disadvantages of increasing space requirements and costs. In addition, the bridle wires require the additional task of installation or assembly, thereby increasing manufacturing costs.

In view of these problems, the inventors have developed a way of replacing the short wires or fuse elements with fusible links consisting of tip and ring conductive traces of a unique construction formed on the printed circuit board.

SUMMARY OF THE INVENTION

Accordingly, it is a general object of the present invention to provide an improved primary/secondary surge protector circuit for protecting telecommunication equipment from power and transient surges which is relatively simple and economical to manufacture and assemble.

It is an object of the present invention to provide an improved primary/secondary surge protector circuit which meets the specifications set forth by UL Standards 497 and 497A.

It is still another object of the present invention to provide an improved primary/secondary surge protector circuit which includes fusible links of a unique construction connected in series with a primary voltage suppressor formed as a single unit on a printed circuit board in order to pass the primary test of the UL Standards 497 and 497A.

It is still yet another object of the present invention to provide an improved primary/secondary surge protector circuit which is characterized by a design wherein fusible links consisting of tip and ring conductive traces of a unique construction are formed on a printed circuit board.

In a preferred embodiment of the present invention, there is provided a primary/secondary surge protector circuit for protecting telecommunications equipment and the like from power and transient

surges which includes a printed circuit board and a surge protector circuit. The surge protector circuit is mounted on the printed circuit board. The printed circuit board has at least one tip conductor trace formed on its top surface and extending between an input tip terminal pin and a first internal node and has at least one ring conductive trace formed on its top surface and extending between an input ring terminal pin and a second internal node.

The surge protector circuit includes a voltage suppressor operative connected to the tip conductive trace at the first node and to the ring conductive trace at the second node. The tip and ring conductive traces define fusible links which are open when an excessive current is passed therethrough.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the present invention will become more fully apparent from the following detailed description when read in conjunction with the accompanying drawings with like reference numerals indicating corresponding parts throughout, wherein:

Figure 1 is a schematic circuit diagram of a prior art primary/secondary surge protector circuit;

Figure 2 is a schematic circuit diagram of another prior art primary/secondary surge protector circuit, similar to Figure 1, but further includes heat coils;

Figure 3 is a schematic circuit diagram of a primary/secondary surge protector circuit, constructed in accordance with the principles of the present invention;

Figure 4 is a schematic circuit diagram of a second embodiment of a primary/secondary surge protector circuit in accordance with the present invention;

Figure 5 is a simplified top plan view of a portion of a printed circuit board, illustrating certain ones of the conductive traces;

Figure 5a is an enlarged view of the encircled area 5a of Figure 5;

Figure 6 is an enlarged, cross-sectional view, taken along the lines 6-6 of Figure 5a;

Figure 7 is a simplified top plan view of a portion of a printed circuit board, illustrating an alternate embodiment of certain ones of the conductive traces;

Figure 7a is an enlarged view of the encircled area 7a of Figure 7; and

Figure 8 is an enlarged, cross-sectional view, taken along the lines 7-7 of Figure 7a.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It is to be distinctly understood at the outset that the present invention shown in the drawings and described in detail in conjunction with the preferred embodiments is not intended to serve as a limitation upon the scope or teachings thereof, but is to be considered merely as an exemplification of the principles of the present invention.

Referring now in detail to the drawings, there is illustrated in Figure 1 a schematic circuit diagram of a prior art primary/secondary surge protector **10** for protecting telecommunications equipment from power and transient surges occurring on tip and/or ring conductors of transmission lines connected thereto. The surge protector circuit **10** is comprised of a primary protector portion **12** and a secondary protector portion **14**. The primary portion **12** of the surge protector circuit **10** includes first and second data signal conductors **16** and **18**. One end of the first conductor **16** is coupled to an input tip terminal pin **20** and its other end thereof is coupled to an output tip terminal pin **22**. Similarly, one end of the second conductor **18** is coupled to an input ring terminal pin **24** and its other end is coupled to an output ring terminal pin **26**.

The primary portion **12** of the surge protector circuit **10** includes a primary voltage suppressor **28** having a first lead **30** connected to the first conductor **16** at an internal node **32** and a second lead **34** connected to the second conductor **18** at an internal node **36**. A third lead **38** of the voltage suppressor **28** is connected to a ground potential. A first bridle wire **40** in the form of a short piece of gauged wire or fuse element is interconnected between the input tip terminal pin **20** and the internal node **32**. A second bridle wire **42** in the form of a short piece of gauged wire or fuse element is interconnected between the input ring terminal pin **24** and the internal node **36**.

The secondary portion **14** of the surge protector circuit **10** includes a pair of positive thermal coefficient (PTC) resistors **44, 46**, a differential voltage suppressor **48**, and an isolation transformer **50**. The differential voltage suppressor **48** is connected in parallel across the primary windings **P** of the transformer **50** at nodes **50, 54** respectively. The PTC resistor **44** has its ends interconnected between the output tip terminal pin **22** and the node **52**. The PTC resistor **46** has its ends interconnected between the output ring terminal pin **26** and the node **54**.

The secondary portion **14** further includes a secondary voltage suppressor **56** and a relay **58**. The secondary voltage suppressor **56** is connected in parallel across the secondary windings **S** of the transformer **50** at nodes **60, 62** respectively. The relay **58** is interconnected between the respective nodes **60, 62** and corresponding equipment

terminals **64, 66** which are connected to the telephone communications equipment (not shown) to be protected.

As previously pointed out, in the primary protector portion **12** the primary voltage suppressor **28,** the first short piece of gauged wire or fuse element (bridle wire **40**) and the second short piece of gauged wire or fuse link (bridle wire **42**) are all mounted on a printed circuit board. As a result, the primary protector portion **12** suffers from the drawbacks of increased space requirements and higher costs. Further, the added task required for installing or assembling of the bridle wires **40, 42** will also increase time-consuming labor costs during manufacturing.

In Figure 2, there is shown a schematic circuit diagram of another embodiment of a prior art primary/secondary surge protector circuit **210** for protecting the telecommunications equipment. The surge protector circuit **210** is comprised of a primary protector portion **212** and a secondary protector portion **214.** The primary portion of the surge protector circuit **210** includes first and second data conductors **216** and **218.** One end of the first conductor **216** is coupled to an input tip terminal pin **220** and its other end thereof is coupled to an output tip terminal pin **222.** Similarly, one end of the second conductor **218** is coupled to an input ring terminal pin **224** and its other end thereof is coupled to an output ring terminal pin **226.**

The primary portion **212** of the surge protector circuit **210** includes an primary voltage suppressor **228** having a first lead **230**

connected to the first conductor **216** at an internal node **232** and a second lead **234** connected to the second conductor **218** at an internal node **236**. A third lead **238** of the voltage suppressor **228** is connected to a ground potential. A first bridle wire **240** in the form of a short piece of gauged wire or fuse element is interconnected between the input tip terminal pin **220** and the internal node **232**. A second bridle wire **242** in the form of a short piece of gauged wire or fuse element is interconnected between the input ring terminal pin **224** and the internal node **236**. As thus far described, the primary portion **212** is identical to the primary portion **12** of Figure 1. In addition, the primary portion **212** includes a first heat coil **233** interconnected between the internal node **232** and the output tip terminal pin **222** and a second heat coil **237** interconnected between the internal node **236** and the output ring terminal pin **226**.

Since the secondary portion **214** is identical in its construction to the secondary portion **14** of Figure 1, it is believed unnecessary to describe in detail the same. However, it should be noted that the surge protector circuit **210** of Figure 2 suffers from all of the same disadvantages of the surge protector circuit **10** of Figure 1.

In order to overcome all of the problems associated with the surge protector circuits of Figures 1 and 2 but yet still pass the primary test according to the specifications set forth by UL Standards 497 and 497A, the inventors of the present invention have developed an improved primary/secondary surge protector circuit which includes fusible links of a unique construction for replacing the short pieces

of gauged wire or fuse elements shown in Figures 1 and 2. The fusible links take the physical form of tip and ring conductive traces which are especially designed to have predetermined width and height (thickness) dimensions. By varying the width and height dimensions of the conductive traces, the conductive traces can be made to correspond to any one of a number of wire gauge sizes, such as #28 AWG size or less, respectively. The conductive traces will create a discontinuity or open up when heated due to an excessive current being passed through it.

With reference now to Figure 3 of the drawings, there is depicted a schematic circuit diagram of an improved primary/secondary surge protector circuit **310** for protecting telecommunications equipment from power and transient surges occurring on tip and/or ring conductors of transmission lines connected thereto, constructed in accordance with the principles of the present invention. The surge protector circuit **310** is comprised of a primary protector portion **312** and a secondary protector portion **314**. The primary portion **312** of the surge protector circuit **310** includes first and second data signal conductors **316** and **318**. One end of the first conductor **316** is coupled to an input tip terminal pin **320** and its other end thereof is coupled to an output tip terminal pin **322**. Similarly, one end of the second conductor **318** is coupled to an input ring terminal pin **324** and its other end thereof is coupled to an output ring terminal pin **326**.

The primary portion **312** of the surge protector circuit **310** includes a primary voltage suppressor **328** having a first lead **330**

connected to the first conductor **316** at an internal node **332** and a second lead **334** connected to the second conductor **318** at an internal node **336**. A third lead **338** of the voltage suppressor **328** is connected to a ground potential. A first fusible link **340** in the form of tip conductive trace is interconnected between the input terminal pin **320** and the internal node **332**. A second fusible link **342** in the form of a ring conductive trace is interconnected between the input ring terminal **324** and the internal node **336**. All of the electrical components between the input terminals **320, 324** and the output terminals **322, 326** are formed as a single unit on a printed circuit board.

The primary voltage suppressor **328** may be formed of a silicon avalanche suppressor (SAS), sidactor, gas discharge tube or other similar devices which have predetermined breakdown voltages that are relatively high, preferably in the range of approximately 200-600 volts. In the preferred embodiment, the primary voltage suppressor **328** is a silicon avalanche suppressor similar to type 1.5 KE.

The secondary portion **314** of the surge protector circuit **310** is identical in its construction to the secondary portion **14** of Figure 1. In particular, the secondary portion **314** of the surge protector circuit **310** includes a pair of positive thermal coefficient (PTC) resistors **344, 346,** a differential voltage suppressor **348,** and an isolation transformer **350**. The differential voltage suppressor **348** is connected in parallel across the primary windings **P** of the transformer **350** at nodes **352, 354** respectively. The PTC resistor **344** has its ends interconnected between the output tip terminal pin **322** and

the node **352**. The PTC resistor **346** has its ends interconnected between the output ring terminal pin **326** and the node **354**.

The secondary portion **314** further includes a secondary voltage suppressor **356** and a relay **358**. The secondary voltage suppressor **356** is connected in parallel across the secondary windings **S** of the transformer **350** at nodes **360, 362** respectively. The relay **358** is interconnected between the respective nodes **360, 362** and corresponding equipment terminals **364, 366** which are connected to the telephone communications equipment (not shown) to be protected.

The unique construction of the fusible links **340** and **342** formed on a printed circuit board is best understood by reference to Figures 5, 5a and 6. As can be seen from Figures 5 and 5a, the fusible links **340** and **342** are identical in their construction and take the physical form of respective tip and ring conductive traces which are located on the top surface of a printed circuit board **500**. The tip conductive trace **340** extends between the input tip terminal pin **320** and the internal node **332**. Similarly, the ring conductive trace **342** extends between the input ring terminal pin **324** and the internal node **336**. Each of the tip and ring conductive traces **340, 342** has a uniform width **W** and height **H** along the path between the respective input terminal pins and the corresponding internal nodes.

In Figure 6, there is shown an enlarged cross-sectional view of the ring conductive trace **342** taken along the lines 6-6 of Figure 5a. It will be noted that the width **W** has typically a dimension of ap-

proximately .040 inches, and the height **H** has a dimension of approximately .0028 inches so as to correspond to approximately a #28 AWG size. However, it should be clearly understood to those skilled in the art that the width and length dimensions can be varied as desired so as to correspond to any one of a number of gauged wire sizes.

With reference now to Figure 4 of the drawings, there is illustrated a schematic circuit diagram of a second embodiment of an improved primary/secondary surge protector circuit **410** for protecting the telecommunication equipment in accordance with the present invention. The surge protector circuit **410** is comprised of a primary protector portion **412** and a secondary protector portion **414**. The primary portion of the surge protector circuit **410** includes first and second data signal conductors **416** and **418**. One end of the first conductor **416** is coupled to an input tip terminal pin **420** and its other end thereof is coupled to an output tip terminal pin **422**. Similarly, one end of the second conductor **418** is coupled to an input ring terminal pin **424** and its other end thereof is coupled to an output ring terminal pin **426**.

The primary portion **412** of the surge protector **410** includes a primary voltage suppressor **428** having a first lead **430** connected to the first conductor **416** and an internal node **432** and a second lead **434** connected to the second conductor **418** at an internal node **436**. A third lead **438** of the voltage suppressor **428** is connected to a ground potential. A first fusible link **440** in the form of a tip conductive trace is interconnected between the input tip terminal pin **420** and the

internal node **432**. A second fusible link **442** in the form of a ring conductive trace is interconnected between the input ring terminal pin **424** and the internal node **436**.

As thus far described, the primary portion **412** is identical to the primary portion **312** of Figure 3. In addition, the primary portion **412** includes a first heat coil **433** interconnected between the internal node **432** and the output tip terminal pin **422** and a second heat coil **437** interconnected between the internal node **436** and the output ring terminal pin **426**. Since the secondary portion **414** is identical in its construction to the secondary portion **314** of Figure 3, it is believed unnecessary to describe in detail the same.

The unique construction of the fusible links **440** and **442** formed on a printed circuit board is best understood by reference to Figures 7, 7a and 8. As can be seen from Figures 7 and 7a, the fusible links **440** and **442** are identical in their construction and take the physical form of respective tip and ring conductive traces which are located on the top surface of a printed circuit board **700**. The tip conductive trace **440** extends between the input terminal pin **420** and the internal node **432**. Similarly, the ring conductive trace **442** extends between the input ring terminal pin **424** and the internal node **436**. Unlike the tip and ring conductive traces **340, 342** of Figures 5, 5a and 6 having a uniform width and height throughout, the conductive traces **440, 442** have a respective reduced or necked-down section **440a, 442a** which has a narrow width **W'** disposed substantially intermediate of wider sections **440b, 442b** and **440c, 442c**.

In Figure 8, there is shown an enlarged cross-sectional view of the ring conductive trace **442**, taken along the lines 7-7 of Figure 7a. It will be noted that the width **W'** in the necked-down sections **442a** has typically a dimension of approximately .020 inches and the height **H'** has a dimension of approximately .0028 inches. However, it should again be clear to those skilled in the art that the width and length dimensions can be varied as desired so as to correspond to a particular gauged wire size.

From the foregoing detailed description, it can thus be seen that the present invention provides an improved primary/secondary surge protector circuit for protecting telecommunication equipment and the like from power surges which includes a printed circuit board and a surge protector circuit. The surge protector circuit is mounted on the printed circuit board. The printed circuit board has tip and ring conductive traces formed on its top surface so as to define fusible links which are opened when an excessive current is passed therethrough. The conductive traces are dimensioned so as to pass the primary test according to the specifications set forth by UL Standards 497 and 497A.

While there has been illustrated and described what is at present considered to be a preferred embodiment of the present invention, it will be understood by those skilled in the art that various changes and modifications may be made, and equivalents may be substituted for elements thereof without departing from the true scope of the invention. In addition, many modifications may be made to adapt a

particular situation or material to the teachings of the invention without departing from the central scope thereof. Therefore, it is intended that this invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out the invention, but that the invention will include all embodiments falling within the scope of the appended claims.